

Power, electrical costs, efficiency.

Power is the rate of doing work or the rate of change in energy

$P = \text{energy/time}$ in Watts, $W = J/s$

Since Voltage = energy/charge and current = charge/time

$P = VI = \text{energy}/\cancel{q} \times \cancel{q}/t$

Ohm's Law (definition of resistance)

$R = V/I$ $V = IR$ $I = V/R$

$P = VI = (IR)I = I^2R = (V/R)^2R = V^2/R^2 \times R$

$$P = VI = I^2R = V^2/R$$

define: kWh kilowatt hour

unit of energy usage for household electricity

convert kWh into joules

(reminder $W = J/s$)

$1000W \times 3600s = 3600000J = 3.6 MJ$

"Our residential usage charge is a two-tiered Conservation Rate. You pay ^{8.29 cents} per kWh for the first 1,350 kWh you use over an average two-month billing period.

Above that amount, you pay ^{12.43 cents} per kWh — what we call Step 2 — for the balance of the electricity used during the billing period."

8.29 cents per kWh

high usage = 12.43 cents per kWh

$P=VI$ $V=IR$

eg. You connect a 100.0W incandescent bulb and a 25.0W LED light with the same brightness to 120.0V wall voltage.

- A) what is the current drawn by each bulb?
- B) what is kWh usage if they are on 8.0 hours a day for 1.0 year?
- C) How much does it cost to run each bulb for a year at 8.0 hours a day?
- D) what is the resistance of each bulb?
- E) What is the efficiency of the 100W bulb relative to the LED bulb?

Treat the power out as the same (same

brightness).

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next class quiz

test next Wednesday

eg. You connect a 100.0W incandescent bulb and a 25.0W LED light with the same brightness to 120.0V wall voltage.

A) what is the current drawn by each bulb?

$$I = P/V = 100/120 = 0.8333 \text{ A Incandescent}$$
$$= 25/120 = 0.2083 \text{ A LED}$$

B) what is kWh usage if they are on 8.00 hours a day for 1.00 year?

$$8 \times 365.25 = 2,922 \text{ hours/year}$$

$$2922 \times 100 = 292200 \text{ Whours} = 292 \text{ kWh bulb}$$

$$2922 \times 25 = 73050 \text{ Wh} = 73 \text{ kWh LED}$$

C) How much does it cost to run each bulb for a year at 8.00 hours a day?

$$8.29 \times 292.2 = 2,422.338 \text{ cents} = \$24/\text{year}$$

$$8.29 \times 73.050 = 605.5845 = \$6.1/\text{year}$$

D) what is the resistance of each bulb?

★ $P = V^2/R$ $R = V^2/P = 120^2/100 = 144 \Omega$
 $120^2/25 = 576 \Omega$ LED

A) What is the efficiency of the 100W bulb relative to the LED bulb?

25% efficient if the LED is 100%

$$\begin{aligned} \text{efficiency} &= P_{\text{out}}/P_{\text{in}} = \\ &25\text{W}(\text{light})/100\text{W}(\text{electrical energy}) \\ &= 0.25 = 25\% \end{aligned}$$

Ch 22-23 (skip Capacitors)